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AD 680706

NAVAL SHIP SYSTEMS COMMAND

SYMPOSIUM ON TECHNICAL DATA MANAGEMENT

SEPTEMBER 12-14, 1967

GSA AUDITORIUM AT 18TH AND F STREETS, N.W.,

WASHINGTON, D. C.

COMPUTER-AIDED SHIP SPECIFICATIONS

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

ENCL. (1) TO NAVSHIPS LTR SER 2052-T1

Ship specifications are the primary technical documentation, referenced in the contract or purchase order, for the construction of all U. S. Navy ships. The ship specifications contain technical requirements and information relating to the construction of a particular ship or class of ships and describe the essential features, functions, and arrangements. Together with the contract drawings and contract guidance drawings, they define the work and responsibilities of the shipbuilding contractor in preparing working drawings and other documentation; and building and equipping the ship. Detailed requirements for equipment are contained in referenced documents, such as Military Specifications, and standard or type drawings.

The basis for each ship specification is the General Specifications for Ships of the U. S. Navy (Gen. Specs.). This specification contains requirements generally applicable to all ships and is updated every 3 months. I would like to quote from the preface of the first Gen. Spec. This preface is dated July 22, 1908, so you can see the Gen. Specs. have been around for quite a while.

> In order to secure, as far as practicable, uniformity of practice, workmanship, and procedure in the construction of vessels of like type at the various building yards, and to avoid unnecessary repetition . . . . .

You can see that the intent of the Chief Constructor in issuing the Gen. Specs. was to achieve standardization of shipbuilding practices and specifications. Detail (ship) specifications were first prepared

in an inference style, containing statements of exceptions and additions to the Gen. Specs. This was later changed to a ship specification format consisting of page and line changes to the Gen. Specs. In 1958 a new system of printing called Cardotype allowed us to go to a self-contained ship specification, and still retain the standardized text from the Gen. Spec. In this system each line of text is typed on a standard EAM card. These cards are processed through a high speed camera and the resulting negative used in a standard printing process. The Gen. Spec. deck of cards is used for ship specifications, with new cards added and Gen. Spec cards removed as necessary. This system greatly reduces the amount of typing and proofreading necessary and therefore reduces errors.

In one of our early self-contained specifications a typist was carrying a tray of cards to the camera to be processed. She dropped the tray and cards spilled all over the floor. Being new at the job and maybe not too sure of her job security, she hurriedly put the cards back in the tray and continued on her way. You can imagine what the resulting portion of the specifications, did to our confidence in the system.

I would like to go briefly into how we presently prepare ship specifications.

A single column copy of the Gen. Spec. is used as the basis. This specification is broken into sections and distributed to the cognizant NAVSEC branches. One engineer is responsible for each section, obtaining information from other branches as necessary to complete the section. The single

column Gen. Spec. is marked up by crossing out the material that is not applicable and adding material unique to that design, as well as other standard information applicable to that particular type of ship.

On a preassigned date the specification sections are assembled, checked for compatability, accuracy and completeness and sent to be duplicated by a direct photographic process. The resulting copies of the marked up specifications are packaged with the contract drawings and contract guidance drawings and circulated for comment, to approximately 60 different NAVSEC and NAVSHIPS branches and interested Navy activities.

Comments on each section are forwarded to the cognizant code, for the section, for adjudication and update of the master copy.

The specifications are then reassembled, and in conjuction with the drawings, reviewed, as a package, for correctness and compatability by the appropriate engineers at a technical reading session.

A final coordination review is held for the ship Project Manager and NAVSEC Project Coordinators, followed by the approval signature of the design package and final typing and printing.

In 1964, serious consideration was given to use of the computer to prepare ship specifications. Prior to this time various methods of using automatic data processing equipment had been investigated and rejected. After considerable preliminary planning and investigation, a contract was awarded to the RCA Service Company on 2 September, 1966 to

develop the computer programs. These programs have been developed and are presently being revised to include preparation of a list of referenced documents. The programs use the IBM 7090 and the IBM 360/30 computers. Preparation of the master specification tape file has not yet been started, except for 5 trial sections used in developing and validating the programs.

Figures 1, 2, 3, and 4 are examples of the Gen. Spec. computer output. Note that the computer both left and right justifies each line. The print chain contains two upper case fonts and one lower case. At the time these pages were produced, the program still contained a few bugs. For instance column 1, line 65 in Figure 1, is not properly indented. However the program has now been debugged. Figure 1 shows mathematical equations in the text. Figure 2 is a single column printout used by the engineer in checking the specifications. The blank side of the page is used by the engineer for entering comments and changes. Figure 3 has a one-column table; and Figure 4 has a two-column table.

The master file will be prepared by adding to the Gen. Specs. that material presently included in ship specifications, but not suitable for inclusion in the Gen. Spec. Material, such as specific design heads for structure, which can be included in the master file with blank spaces left for insertion of the appropirate figures, is an example.

Figure 5 shows how the master file will be broken into units of

information. You will note the varying lengths of the units. These can range from a single punction mark to several paragraphs or even several pages. Each unit is assigned a descriptor number in the left hand margin.

Note the editorial corrections. "Plans" is no longer used, so it has been changed to "drawings". The word "explicitly" has been changed to correct the spelling. The computer chain used to print the output in the automated system does not have a square root sign. Consequently, the words must be spelled out.

Concurrently with the preparation of the master file, a Yes/No questionnaire is prepared, Figure 6. Each unit of information is tied to a question by means of the descriptor number. A Yes answer to a question means that the corresponding unit or units of information will be printed in the ship specification. The questions will be combined to insure that each question needs to be answered only once, to withdraw the corresponding information, whereever it may be, throughout the specifications. One of the computer programs sorts the questionnaire by functional area of NAVSEC branch cognizance. Figure 7 shows a sample questionnaire printout sorted for one branch. This sort capability enables us to assign each question to the engineer most qualified to answer it, regardless of the units location in the specification. For instance, the section on painting contains a statement similar to: "The rudder(s) shall be coated the same as the adjacent structure." The paint specialist doesn't necessarily care how many rudders the ship

has, but under the present system he must find out in order to properly write the sentence. With the new procedure, when the question on the number of the rudders is answered for the rudder section of the ship specification, it will automatically print the right word in the painting section.

Figure 8 illustrates a portion of the specification as it appears in the master file. The figure "110" in column 1 refers to the section, in this case section 9110-0 of the Gen. Spec. or any ship specification. The next column, from "120" to "230" indicates the unit number within that section. The third column indicates the line within the unit. The next column of figures, running from "3" to "68" are descriptor numbers, tieing the unit of text to a particular question. The "N" in the next column stands for non-Gen. Spec. material. By one command the program can delete this material and print a completely up to date Gen. Spec. The figures and letters in the next column are an external edit code controlling paragraphing, identation etc. Burried within the text is an internal edit code controlling type font, spacing etc.

The last six-digit control number is presently unused and provides sufficient flexibility for later improvements in the system. We must recognize that this computer program can also be used to print any material, where there some logic between reading for printing or not printing the material. This extra control field might be required for some of these later programs, such as the preparation of Military Specifications.

Note the formula in figure 8 and as it appears in figure 9 with the internal edit codes processed.

Presently the Gen. Specs. are revised quarterly, with the computer program the master tape can be updated daily if necessary or at least immediately prior to each ship specification or Gen. Spec. printout, therefore the latest available information will always be included.

The system will also produce a listing of all references contained in the specifications. The listing will be produced by specification paragraph number for review. This review will insure that all references are current and correct. The final printout will be in alpha-numeric order by category, such as, all Military Specifications sorted in numeric order.

Now lets go through the preparation of a ship specification using the computer system.

Once the ship design is developed to the point where all the questions can be answered, the computer prints an up to date questionnaire sorted by cognizant code. These questionnaires are distributed to the proper engineers. The engineer answers each question Yes or No. Since each engineer involved will be checking only questions which are the center of his concern, for a design which he has just completed, it is anticipated that the time required for completion of this questionnaire by individual engineers will be negligable.

The yes answers are keypunched and fed into the computer (IBM 7090). In effect, the computer reads a bit string indicating the applicability of descriptor numbers. It then enters an array of each descriptor and selects the applicable unit numbers. The computer then sorts the units into the correct order and prints a tape. This tape is the ship tape for that particular ship design. All future processing of this tape is on the IBM 360/30 computer.

The ship tape is processed to interpret the internal and external edit codes and format the pages including assigning page and line numbers. This original specification is produced in a single column format, using the universal character set chain. The ship tape contains no descriptor numbers or unit numbers and all future changes to this tape are made by use of the page and line numbers.

This specification is broken into sections and distributed to the appropriate engineers for review and adding of any needed additional information. The time required for this step depends on how effective we are in preparing the master tape and how well we succeed in keeping

it current. Corrections are coded, keypunched, and fed into the computer to produce the comment copy, again a single column copy. The comment copy computer output is reproduced by a standard printing process to provide the copies required for circulation for comments. From this point to signature, the process is the same as under the present system. After signature the corrections are coded, keypunched and fed into the computer to produce the final double column ship specification.

Advantages

A large portion of the Ship Systems Engineering and Design Department manpower is used to produce ship specifications. This computer-aided ship specification system will greatly reduce this engineering manpower requirement.

By using a Yes/No questionnaire we can assign preparation responsibility, for each unit of information, to the engineer most knowledgable of the area, in lieu of the present method of assigning preparation responsibility by specification sections. This also reduces the chance for conflict between sections of the specifications.

By putting all generally used non-Gen. Spec. material in the computer, we standardize the wording and prevent each engineer from using slightly different wording and possibily getting different interpretations at the user end. It is not uncommon to receive a telephone call from a shipbuilder asking "Why did you change 'such and such' requirement in the specification?" and to discover that, in fact, there was no intention to change the specification, but that different wording was used by a different engineer.

One of the major sources of error or conflict in the ship specifications is last minute changes in the design. Presently we catch the obvious places, but someone doesn't get the word and one or more affected requirements remain unchanged. With our questionnaire and descriptors we can rapidly locate all the text that requires change.

Problems and Future Improvements

The biggest problem is to get the master tape accurate and complete, and to insure that it is maintained current at all times. The manpower and effort required, must be expended to insure this initial accuracy. Also, changes must be made with the least possible effort on the part of the engineer, while still maintaining strict control of all changes.

Computer output has many limitations when compared with standard printing, such as legability, and range of type fonts and characters available. We are investigating the use of the Linotron, presently being installed at the Government Printing Office. This equipment takes standard computer tape and processes it through a standard printing process. Our early checks show that only minor changes will be required in our present computer system to use the Linotron for our output device.

We may want in the future to reduce the quantity of questions to be answered for each ship specification. This would involve having several questionnaire tapes, one for surface ships, one for submarines, one for commercial type ships, etc., or by adding another program to the system we may be able to do this by answering certain key questions prior to the printout of the questionnaire.

Presently the system uses a card input, several possibly more efficient methods are presently available, or are under development. These are being followed with interest and will be considered for future inclusion in the system.

In summary, we have now developed a system which permits us to do an excellent job of preserving experience, standardizing ship specifications, assuring completeness, coping with dynamic technology, and assuring that the ship specifications are tailored to the particular project. Additionally, the system produces an output which is easily used, and which can be produced at a reduced cost, both in preparation and in use.

K1 area
K3 area

K2 area
K4 area

GENERAL SPECIFICATIONS FOR SHIPS
OF THE UNITED STATES NAVY
DEPARTMENT OF THE NAVY
NAVAL SHIP ENGINEERING CENTER

1 JULY 1965

SECTION 9110-0
GENERAL REQUIREMENTS FOR HULL STRUCTURE
Supersedes section S11-0,
Dated 1 January 1963

9110-0-a. Design

General.-The contractor shall assure that the scantlings depicted on the intended purpose. Compliance with such drawings or subsequent approval of changes made by the Contractor does not relieve the Contractor from making the necessary structural calculations, preparing an adequate structural design, and building an adequate ship structure in accordance with the design criteria given herein. Ship structure shall be designed so that allowable stresses or deflections will not be exceeded, and failure will not occur from a condition of elastic instability. Design Data Sheets DDS9110-1, DDS9110-2, DDS9110-3, and DDS9110-4 illustrate acceptable methods of ship structural design.

Structure for which loads are not explicitly specified shall be rugged enough to withstand the stresses which can reasonably be expected in service. Additional local stiffening, if found necessary, shall be installed to prevent excessive vibration, panting, or springing of plating.

Design loads.-Ship structure shall be designed to withstand the following loads

Ship bending.- The bending loads on the hull as a whole from gravity and inertia forces, with the ship statically balanced in hogging and sagging conditions. Waves shall be assumed to be trochoidal, of length L and height 1.1 times the square root of L, where L is the length of the ship between perpendiculars, in feet. For the design of members which constitute the longitudinal strength girder, ship-bending stresses (tension and be assumed to be ½ of the larger of the values calculated for the extreme fibers. (See DDS9290-2). Stresses shall the neutral axis to the extreme fibers.

Deck live loads.- As specified.

Dead loads.-Weights of structure and equipment.

Ship motion.- Inertia forces and gravity components resulting from motion of the ship in a seaway.

Sea forces.- Static-equivalent heads, representing the effects of wave action on the shell and weather decks.

Tank pressures.- Hydrostatic heads on tank boundaries, including the effects of filling to overflow.

The foregoing design loads, where applicable, shall be combined to produce the most adverse conditions of stress. Structure shall also be designed for the following loadings, considered individually

Flooding.-Hydrostatic head, to the damage-control deck, on the boundaries of any combination of watertight compartments.

Gun blast.-A static equivalent head, in feet of sea water, equal to

$$\frac{450(1 + \cos X)^2}{(R/D)^{1/2}}$$

where
R is the radius vector, in inches, from the muzzle of

the nearest gun to the point in question; inches;

X is the space angle between the radius vector and the axis of the gun barrel.

Missile blast.- Static equivalent head, in feet of sea water, equal to

2.25T(sin Y+0.0225/sin Y)/A

where
T is the total thrust of the missile, in pounds;

Y is the angle of incidence (ranging from 20 to 90 degrees);
A is the area of the surface in question, in square inches, bounded by the blast cone. (The blast cone is generated by rotating, about the missile axis, a line having a three-degree divergence from the axis and passing through the circumference of the exit nozzle.)

Accidental missile ignition.- A static-equivalent head, in feet of sea water, equal to

4.5R/A

where
booster, in

pounds per second;
blowout openings. (Such openings, having hinged covers and vented to the atmosphere, shall be provided for missile magazines, assembly rooms, and check-out areas.)

Allowable stresses.- Under the design loads, stresses in structural members, excluding bending stresses in plating panels, shall not exceed the following allowable limits

Tensile and bending stresses.- Where there is no danger of failure from

K5 area

K6 area

FIGURE 1

K1 area K2 area
K3 area K4 area

GENERAL SPECIFICATIONS FOR SHIPS
OF THE UNITED STATES NAVY
DEPARTMENT OF THE NAVY
NAVAL SHIP ENGINEERING CENTER

1 JULY 1965

SECTION 9110-0
GENERAL REQUIREMENTS FOR
HULL STRUCTURE
Supersedes section S11-0,
Dated 1 January 1963

9110-0-a. Design

General.-The contractor shall assure that the scantlings depicted on the structural drawings are adequate for the intended purpose. Compliance with such drawings or subsequent approval of changes made by the Contractor does not relieve the Contractor from making the necessary structural calculations, preparing an adequate structural design, and building an adequate ship structure in accordance with the design criteria given herein. Ship structure shall be designed so that when subjected to specified loads, the allowable stresses or deflections will not be exceeded, and failure will not occur from a condition of elastic instability. Design Data Sheets DDS9110-1, DDS9110-2, DDS9110-3, and DDS9110-4 illustrate acceptable methods of ship structural design.

Structure for which loads are not explicitly specified shall be rugged enough to withstand the stresses which can reasonably be expected in service. Additional local stiffening, if found necessary, shall be installed to prevent excessive vibration, panting, or springing of plating.

Design loads.-Ship structure shall be designed to withstand the following loads

Ship bending.- The bending loads on the hull as a whole from gravity and inertia forces, with the ship statically balanced in hogging and sagging conditions. Waves shall be assumed to be trochoidal, of length L and height 1.1 times the square root of L, where L is the length of the ship between perpendiculars, in feet. For the design of members which constitute the longitudinal strength girder, ship-bending stresses (tension and compression) at the neutral axis shall be assumed to be ½ of the larger of the values calculated for the extreme fibers. (See DDS9290-2). Stresses shall be assumed to increase uniformly from the neutral axis to the extreme fibers.

Deck live loads.- As specified.

Dead loads.-Weights of structure and equipment.

Ship motion.- Inertia forces and gravity components resulting from motion of the ship in a seaway.

Sea forces.- Static-equivalent heads, representing the effects of wave action on the shell and weather decks.

Tank pressures.- Hydrostatic heads on tank boundaries, including the

K5 area K6 area

FIGURE 2

K1 area
K3 area

K2 area
K4 area

GENERAL SPECIFICATIONS FOR SHIPS

DEPTH OF WEB	MAXIMUM DIAMETER OF HOLE	SPACING CENTER TO CENTER
Inches	Inches	Inches
6	2	6
7	2½	2½
8	3	7
9	3½	7½
10	4	8
11	4	8
12	4½	9
13	5	10
14 and 15	5 by 9(1)	(3)
16 to 18 incl.	6 by 9(1)	(3)
over 18	(2)	(3)

(1) Long dimensions shall be parallel to the girder.

(2) Depth of hole shall not exceed 40 percent of the depth of web, and the length of hole shall not exceed twice its own depth.

(3) Holes shall be spaced so that the distances between edges of adjacent holes will not be less than one and one-fourth times the length of the holes.

For submarines, the

F>r submarines. lightening holes in transverse floors shall be increased in size in locations where quick flooding demands fore and aft flow of water through the frame. Where this is done, the weight of the floors shall be increased to maintain the strength of the floors, and flat bar reinforcement shall be fitted around the edges of the holes.

Corner radii of rectangular openings in pressure hull plating shall be as specified in 9110-1.

Drain holes.- In nontight structure, drain holes shall be cut and water courses provided to prevent the accumulation and retention of liquids and to permit their free flow to drains, scuppers, sumps, and suction pipes. In nontight portions of bottom longitudinals and the vertical keel, drain holes shall be located to insure drainage of each bay formed by longitudinals and transverse frames. In compartments fitted with suction piping, the total area of drain holes through any frame or longitudinal shall be at least twice the area of the largest suction pipe.

The number and size of drain holes may be reduced by including the area of cutouts for shell seams and butts where they are available for drainage.

In large structural castings and weldments, drain holes shall be provided to insure complete drainage.

Air holes.- In nontight structure of tanks and bottom compartments that are fitted with filling and drainage arrangements, air holes shall be provided to prevent the formation of air or gas pockets and to provide clear passage to air escape pipes.

9110-0-c. Workmanship

Fairness.

For surface ships

Departures from the molded form shall be held within the following limits

Plus or minus ½ inch from the vertical longitudinal center plane.

Plus or minus 1 inch in 100 feet of length.

Plus or minus ½ inch vertically from the base line.

For submarines

Circularity measurements of pressure hull plating shall be taken throughout those portions of the pressure hull and pressure hull appendages which are intended to be circular.

All circularity measurements shall be taken on the pressure hull plating. If measurements are taken on the surface of the plating to which frames are attached, the measurements shall be taken as close to the frames as is practicable. If measurements are taken on the surface of the plating opposite that to which frames are attached, the measurements shall be taken on the frame line.

Circularity measurements shall be taken in the following locations

One set shall be taken on or adjacent to each deep frame.

One set shall be taken on or adjacent to the first unsupported frame both forward and aft of each full diameter internal bulkhead. (The frame adjacent to a bulkhead can be considered to be supported if the vertical and horizontal bulkhead stiffeners are bracketed to the frame.)

One set shall be taken on or adjacent to each frame both forward and aft of each full circumferential butt.

One set shall be taken on or adjacent to at least every third frame.

Circularity measurements shall be taken so that a complete trace of the actual contour of the hull may be obtained at each station even though tanks forming a part of the ship's structure are located inside the pressure hull.

A circle whose area equals the area enclosed by the trace of the actual contour shall be drawn. This circle shall be considered to be the mean circle.

The mean circle may be positioned over the actual contour so that deviations between the mean circle and the contour are minimized.

The following requirements for circularity shall be met

The trace of the actual contour shall not deviate from the mean circle by more than ½ the thickness of the pressure hull plating or ½ inch, whichever is less.

The radius of the mean circle shall not depart from the design radius by more than ½ the thickness of the pressure hull plating or ½ inch, whichever is less.

Measurements shall be taken after all major welding in the vicinity has been completed. The installation of closure plates shall be considered major welding

K5 area

K6 area

FIGURE 3

TABLE 1

Use	Spec. No.	Alloy	Condition Grade or Class	Remarks
Castings	QQ-A-601			
		356	3M	Note 1
Castings	QQ-A-601			
		195	4M	Note 2
Castings	QQ-A-601	214	5M	Note 3
Plates	QQ-A-250/7	5086	H32	Note 4
Plates	QQ-A-250/9	5456	H321	Note-5
Plates	QQ-A-250/10	5454	H34	Note 6
Plates	QQ-A-250/11	6061	T6	Note 7
Shapes				
Extruded or rolled	QQ-A-200/5	5086	H111	Note 4
Extruded	QQ-A-200/7	5456	H111	Note 5
Extruded or rolled	QQ-A-200X/6	5454	H111	NOTE 6
ROLLED OR DRAWN	QQ-A-225/8	6061	T6	Note 7
Extruded	QQ-A-200/8 or			
	ASTM B221	6061	T6	Note 7
Tubing				
*Drawn or extruded	WW-T-700/5	5086	H32	Note 4
**Welded	QQ-A-250/7	5086	H32	Note 4
All sizes	WW-T-700/6	6061	T6	Note 7

Note 1 - For use with complex castings where castability, pressure tightness, strength, and resistance to corrosion are required. Will respond to heat treatment to improve strength. For applications requiring high casting quality and excellent fluidity.

Note 2 - High tensile, with less corrosion resistance than class 1, 3, 5, 7, and 8. Heat treatment is required. For uses such as ammunition stowages, frames and sills for joiner doors, and ladder treads.

Note 3 - For use wherever good tensile strength and relatively high resistance to corrosion is required. Heat treatment is not required. For applications similar to class 4 but requiring resistance to corrosion at a sacrifice of tensile properties.

Note 4 - Shall be used for applications where higher strength is not required.

Note 5 - Shall be used for applications where high strength is required and where higher cost is warranted.

Note 6 - For structure subject to elevated temperatures over 150 degrees F., such as upper portion of smokestacks.

Note 7 - This alloy shall be used for nonwelded structure only.

*Drawn preferred - Consideration must be given to wider dimensional tolerances when extruded tubing is used.

**Tubing manufactured from plate and having a longitudinal welded seam may be used for tubing sizes that are not available in drawn tubing.

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0 GENERAL SPECIFICATIONS FOR SHIPS
OF THE UNITED STATES NAVY

DEPARTMENT OF THE NAVY
1 NAVAL SHIP ENGINEERING CENTER
1 JULY 1965

0 **SECTION 9110-0**
GENERAL REQUIREMENTS FOR
0 **HULL STRUCTURE**
Supersedes section 9110-0, dated 1 January 1963

1 **9110-0-a. Design**

0 **General.**—The Contractor shall assure that the scantlings depicted on the structural plans are → drawings adequate for the intended purpose. Compliance with such plans ~~or subsequent approval of changes made~~ by the Contractor does not relieve the Contractor from making the necessary structural calculations, preparing an adequate structural design, and building an adequate ship structure in accordance with the design criteria given herein. Ship structure shall be designed so that when subjected to specified loads, the allowable stresses or deflections will not be exceeded, and failure will not occur from a condition of elastic instability. Design Data Sheets *DDS9110-1, DDS9110-2, and DDS9110-4* illustrate acceptable methods of ship structural design.

2

Structure for which loads are not explicitly → explicitly specified shall be rugged enough to withstand the stresses which can reasonably be expected in service. Additional local stiffening, if found necessary, shall be installed to prevent excessive vibration, panting, or springing of plating.

3 **Design loads.**—Ship structure shall be designed to withstand the following loads:

2 **Ship-bending.**—The bending loads on the hull as a whole from gravity and inertia forces, with the ship statically balanced in hogging and sagging conditions. Waves shall be assumed to be trochoidal, of length L and height 1.1 → times the square root of L, ~~$\sqrt{L}$~~ where L is the length of the ship between perpendiculars, in feet. 3 For the design of members which constitute the longitudinal strength girder, ship-bending stresses (tension and compression) at the neutral axis shall be assumed to be one-half of the larger of the values calculated for the extreme fibers. (See DDS9290-2). Stresses shall be assumed to increase uniformly from the neutral axis to the extreme fibers.

4 **Deck live loads.**—As specified.

Dead loads.—Weights of structure and equipment.

AUTOMATED QUESTIONNAIRE FORM FOR THE GENERAL SHIP SPECIFICATION SYSTEM

SECTION NO.	NAVSEC CODE	DESCRIPTOR NO.	YES	NO	QUESTION
110	6445	1			APPLIES TO GEN. SPEC. ONLY
110	6445	2			IS THIS A SURFACE SHIP
110	6443	3			IS THIS A LONGITUDINALLY FRAMED SURFACE SHIP
110 110	6443 6443	4			IS THIS A SURFACE SHIP WITH COMPARTMENT BOUNDARIES DESIGNED TO A HEAD TO THE DAMAGE CONTROL DECK
110	6447	5			IS THIS A SURFACE SHIP WITH GUNS
110	6447	6			IS THIS A SURFACE SHIP WITH A MISSILE LAUNCHER
110	6447	7			IS THIS A SURFACE SHIP WITH ONE MISSILE MAGAZINE
110	6447	8			IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE MAGAZINE
110	6447	9			IS THIS A SURFACE SHIP WITH ONE MISSILE ASSEMBLY ROOM
110 110	6447 6447	10 10			IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE ASSEMBLY ROOM
110	6447	11			IS THIS A SURFACE SHIP WITH ONE MISSILE CHECK-OUT AREA
110 110	6447 6447	12 12			IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE CHECK-OUT AREA
110	6443	13			IS THIS A SURFACE SHIP DESIGNED FOR NUCLEAR BLAST
110	6443	14			IS THIS A SURFACE SHIP USING MEDIUM STEEL STRUCTURALLY
110	6443	15			IS THIS A SURFACE SHIP USING HIGH TENSILE STEEL STRUCTURALLY
110	6443	16			IS THIS A SURFACE SHIP USING HY-80 STEEL STRUCTURALLY
110	6443	17			IS THIS A SURFACE SHIP USING ALUMINUM ALLOY STRUCTURALLY

FIGURE 6

AUTOMATED QUESTIONNAIRE FORM FOR THE GENERAL SHIP SPECIFICATION SYSTEM

NAVSEC CODE	SECTION NO.	DESCRIPTOR NO.	YES	NO	QUESTION
6447	110	5			IS THIS A SURFACE SHIP WITH GUNS
6447	110	6			IS THIS A SURFACE SHIP WITH A MISSILE LAUNCHER
6447	110	7			IS THIS A SURFACE SHIP WITH ONE MISSILE MAGAZINE
6447	110	8			IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE MAGAZINE
6447	110	9			IS THIS A SURFACE SHIP WITH ONE MISSILE ASSEMBLY ROOM
6447 6447	110 110	10 10			IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE ASSEMBLY ROOM
6447	110	11			IS THIS A SURFACE SHIP WITH ONE MISSILE CHECK-OUT AREA
6447 6447	110 110	12 12			IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE CHECK-OUT AREA

FIGURE 7

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110   120   6    3 -0     *STRESSES SHALL BE ASSUMED TO INCREASE UNIFORMLY FROM  000000
110   120   7    3 -0     THE NEUTRAL AXIS TO THE EXTREME FIBERS.                000000
110   130   1    2  5LD   -*D)-ECK LIVE LOADS .- *AS SPECIFIED.                  000000
110   130   2    2  5LD   -*D)-EAD LOADS.- *WEIGHTS OF STRUCTURE AND EQUIPMENT.  000000
110   130   3    2  5LD   -*S)-HIP MOTION .- *INERTIA FORCES AND GRAVITY         000000
110   130   4    2  5A    COMPONENTS RESULTING FROM MOTION OF THE SHIP IN A      000000
110   130   5    2 -0     SEAWAY.                                                000000
110   130   6    2  5LD   -*S)-EA FORCES .- *STATIC-EQUIVALENT HEADS.            000000
110   130   7    2  5A    REPRESENTING                                           000000
110   130   8    2 -0     THE EFFECTS OF WAVE ACTION ON THE SHELL AND WEATHER    000000
110   130   9    2 -0     DECKS.                                                 000000
110   130  10    2  5LD   -*T)-ANK PRESSURES .- *HYDROSTATIC HEADS ON TANK       000000
110   130  11    2  5A    BOUNDARIES, INCLUDING THE EFFECTS OF FILLING TO        000000
110   130  12    2 -0     OVERFLOW.                                              000000
110   140   1   2N  5LD   -*D)-YNAMIC SHOCK LOADS.- *DYNAMIC SHOCK LOADS FROM    000000
110   140   2   2N  5A    INSTALLED EQUIPMENT.                                   000000
110   150   1    2 -0LA   *THE FOREGOING DESIGN LOADS, WHERE APPLICABLE, SHALL BE000000
110   150   2    2 -0     COMBINED TO PRODUCE THE MOST ADVERSE CONDITIONS OF     000000
110   160   1    1 -0     STRESS.                                                000000
110   170   1   2N-0      STRESS.                                                000000
110   180   1   2N-0      EXCEPT THAT WHERE COMBINED WITH PRIMARY HULL BENDING   000000
110   180   2   2N-0      STRESSES, SECONDARY STRESSES IN TANKS SHALL BE DETER   000000
110   180   3   2N-0      MINED USING A HEAD TO THE TANK TOP ONLY.               000000
110   190   1    2 -0     *STRUCTURE SHALL ALSO BE DESIGNED FOR THE FOLLOWING    000000
110   190   2    2  1     LOADINGS, CONSIDERED INDIVIDUALLY=                     000000
110   200   1    4  6LD   -*F)-LOODING.- *HYDROSTATIC HEAD, TO THE DAMAGE-CONTROL000000
110   200   2    4  5A    DECK, ON THE BOUNDARIES OF ANY COMBINATION OF          000000
110   200   3    4 -0     WATERTIGHT COMPARTMENTS.                               000000
110   210   1    5  5LD   -*G)-UN BLAST.- *A STATIC EQUIVALENT HEAD, IN FEET OF  000000
110   210   2    5  5A    SEA WATER, EQUAL TO                                    000000
110   210   3    5 -0LS1  (                                                      000000
110   210   4    5  1LS   ((((((((((((((((((((((2                                000000
110   210   5    5 -0LS   ((((((()9-450 1( (COS(X                                000000
110   210   6    5 -0LS   ((((((((((((((((3/2                                    000000
110   210   7    5 -0LS1  (((((((((( 8R/8D                                       000000
110   210   8    5  1LS   WHERE=                                                 000000
110   210   9    5 -0L1   *R IS THE RADIUS VECTOR, IN INCHES, FROM THE MUZZLE OF 000000
110   210  10    5  1     THE NEAREST GUN TO THE POINT IN QUESTION               000000
110   210  11    5 -0L1   *D IS THE DIAMETER OF THE GUN BORE IN INCHES           000000
110   210  12    5 -0L    *X IS THE SPACE ANGLE BETWEEN THE RADIUS VECTOR AND THE000000
110   210  13    5 -0     AXIS OF THE GUN BARREL.                                000000
110   220   1    6  6LA   -*M)-ISSILE BLAST .- *STATIC EQUIVALENT HEAD, IN FEET  000000
110   220   2    6  1S1   OF SEA WATER, EQUAL TO                                 000000
110   220   3    6  1LS1  (((((((2.25*T SIN *Y 0.0225/SIN *Y /*A                 000000
110   220   4    6  1LS   WHERE=                                                 000000
110   220   5    6 -0L1   *T IS THE TOTAL THRUST OF THE MISSILE, IN POUNDS       000000
110   220   6    6  1L    *Y IS THE ANGLE OF INCIDENCE  RANGING FROM 20 TO 90    000000
110   220   7    6  1     DEGREES                                                000000
110   220   8    6 -0L    *A IS THE AREA OF THE SURFACE IN QUESTION, IN SQUARE   000000
110   220   9    6  1     INCHES, BOUNDED BY THE BLAST CONE.  *THE BLAST CONE IS 000000
110   220  10    6 -0     GENERATED BY ROTATING, ABOUT THE MISSILE AXIS, A LINE  000000
110   220  11    6 -0     HAVING A THREE-DEGREE DIVERGENCE FROM THE AXIS AND     000000
110   220  12    6  1     PASSING THROUGH THE CIRCUMFERENCE OF THE EXIT NOZZLE.  000000
110   230   1   68  1LA   -*A)-CCIDENTAL MISSILE IGNITION .- *A STATIC-EQUIVALENT000000
110   230   2   68  1S1   HEAD, IN FEET OF SEA WATER, EQUAL TO                   000000
110   230   3   68  1S1   (((((((4.5*R/*A                                        000000
110   230   4   68  1     WHERE=                                                 000000
110   230   5   68 -0L1   *R IS THE BURNING RATE OF THE MISSILE BOOSTER, IN      000000
110   230   6   68 -0     POUNDS PER SECOND                                      000000
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FIGURE 8

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110   130   2     2   5 1d      Dead loads.-Weights of structure and equipment.
110   130   3     2   5 1d      Ship motion.- Inertia forces and gravity
110   130   4     2   5 a     components resulting from motion of the ship in a
110   130   5     2  -0       seaway.
110   130   6     2   5 1d        Sea forces.- Static-equivalent heads,
110   130   7     2   5 a       representing
110   130   8     2  -0       the effects of wave action on the shell and weather
110   130   9     2  -0       decks.
110   130  10     2   5 1d        Tank pressures.- Hydrostatic heads on tank
110   130  11     2   5 a       boundaries, including the effects of filling to
110   130  12     2  -0       overflow.
110   140   1     2 n 5 1d        Dynamic shock loads.-Dynamic shock loads from
110   140   2     2 n 5 a       installed equipment.
110   150   1     2  -0 1a      The foregoing design loads, where applicable, shall be
110   150   2     2  -0       combined to produce the most adverse conditions of
110   160   1     1  -0       stress.
110   170   1     2 n-0       stress,
110   180   1     2 m-0       except that where combined with primary hull bending
110   180   2     2 n-0       stresses, secondary stresses in tanks shall be deter
110   180   3     2 n-0       mined using a head to the tank top only.
110   190   1     2  -0       Structure shall also be designed for the following
110   190   2     2   1       loadings, considered individually:
110   200   1     4   6 1d        Flooding.-Hydrostatic head, to the damage-control
110   200   2     4   5 a       deck, on the boundaries of any combination of
110   200   3     4  -0       watertight compartments.
110   210   1     5   5 1d        Gun blast.-A static equivalent head, in feet of
110   210   2     5   5 a       sea water, equal to
110   210   3     5  -0 1s1
110   210   4     5   1 1s                                   2
110   210   5     5  -0 1s          450(1 + COS X)
110   210   6     5  -0 1s                     3/2
110   210   7     5  -0 1s1           (R/D)
110   210   8     5   1 1s    where:
110   210   9     5  -0 11    R is the radius vector, in inches, from the muzzle of
110   210  10     5   1       the nearest gun to the point in question;
110   210  11     5  -0 11    D is the diameter of the gun bore in inches;
110   210  12     5  -0 1     X is the space angle between the radius vector and the
110   210  13     5  -0       axis of the gun barrel.
110   220   1     6   6 1a      Missile blast.- Static equivalent head, in feet
110   220   2     6   1 s1    of sea water, equal to
110   220   3     6   1 1s1         2.25T(sin Y+0.0225/sin Y)/A
110   220   4     6   1 1s    where:
110   220   5     6  -0 11    T is the total thrust of the missile, in pounds;
110   220   6     6   1 1     Y is the angle of incidence (ranging from 20 to 90
110   220   7     6   1       degrees);
110   220   8     6  -0 1     A is the area of the surface in question, in square
110   220   9     6   1       inches, bounded by the blast cone. (The blast cone is
110   220  10     6  -0       generated by rotating, about the missile axis, a line
110   220  11     6  -0       having a three-degree divergence from the axis and
110   220  12     6   1       passing through the circumference of the exit nozzle.)
110   230   1    68   1 1a      Accidental missile ignition.- A static-equivalent
110   230   2    68   1 s1    head, in feet of sea water, equal to
110   230   3    68   1 s1          4.5R/A
110   230   4    68   1       where:
110   230   5    68  -0 11    R is the burning rate of the missile booster, in
110   230   6    68  -0       pounds per second;
110   230   7    68  -0 1     A is the total area, in square feet, of blowout
110   230   8    68   1       openings. (Such openings, having hinged covers and
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FIGURE 9